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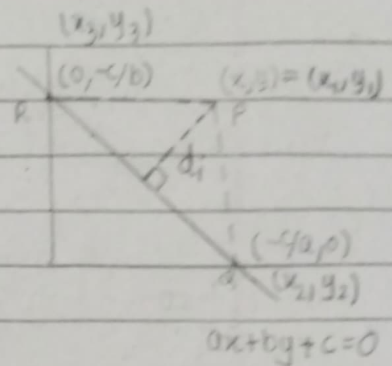
Perpendicular Distance of point from line.

Equation of line $ax+by+c=0$

for $x=0$ for $y=0$

$y = \frac{-c}{b}$ $x = \frac{-c}{a}$



$$\text{Area}(\Delta PQR) = \frac{1}{2}\,\text{Base}\cdot\text{Height}$$

$$\frac{2\cdot \text{Area}(\Delta PQR)}{\text{Base}} = \text{Height} = d_i$$

$$\text{Area}(\Delta PQR) = \frac{1}{2}\left[x_1(y_2-y_3) + x_2(y_3-y_1) + x_3(y_1-y_2)\right]$$

$$= \frac{1}{2}\left[x_1\left(0+\frac{c}{b}\right) + \left(\frac{-c}{a}\right)\left(\frac{-c}{b}-y_1\right)\right]$$

$$= \frac{1}{2}\left[\frac{x_1c}{b} + \frac{c^2}{ab} + \frac{cy_1}{a}\right] = \frac{1}{2}\frac{c}{ab}\left[ax_1 + c + by_1\right] \cdots (1)$$

$$\text{Base} = \sqrt{\left(0-\frac{c}{b}\right)^2 + \left(\frac{-c}{a}+0\right)^2}$$

$$= \sqrt{\frac{c^2}{b^2} + \frac{c^2}{a^2}} = \sqrt{\frac{b^2c^2 + a^2c^2}{a^2b^2}} = \sqrt{\frac{c^2(b^2+a^2)}{a^2b^2}}$$

$$= \frac{c}{ab}\sqrt{b^2+a^2} \cdots (2)$$

$$d_i = \frac{2\cdot\frac{1}{2}\frac{c}{ab}\left[ax_1+by_1+c\right]}{\frac{c}{ab}\sqrt{a^2+b^2}} = \frac{|ax_1+by_1+c|}{\sqrt{a^2+b^2}} \cdots (3)$$

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Minimization of the distance.

The equation of straight line.

$y_i = mx_i + c$

$\Rightarrow \quad mx_i - y_i + c = 0 \qquad\qquad ax + by + c = 0$

here $a = m$, $b = -1$

equation (3) becomes

$$d_i = \frac{|mx_i - y_i + c|}{\sqrt{m^2+1}} = \hat{\epsilon}_i$$

$$D(m,c) = \sum_{i=1}^{n} d_i(m,c)$$

$$\frac{\partial l}{\partial m} \left(\frac{mx_i - y_i + c}{\sqrt{m^2+1}}\right)^2$$

$$\frac{\partial}{\partial m} \frac{(mx_i - y_i + c)^2}{m^2+1} =$$

$$= \sum_{i=1}^{n} \frac{2(m^2+1)(mx_i - y_i + c)x_i - 2m(mx_i - y_i + c)^2}{(m^2+1)^2}$$

$$= \sum_{i=1}^{n} \frac{2x_i(mx_i - y_i + c)}{m^2+1} - \frac{2m(mx_i - y_i + c)}{(m^2+1)^2}$$

Now

$$\frac{\partial}{\partial c} \frac{(mx_i - y_i + c)^2}{m^2+1}$$

$$= \sum_{i=1}^{n} \frac{2(mx_i - y_i + c)}{m^2+1}$$